UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/704,539	11/03/2000	Ken Kitamura	44084-479	4655

7590 03/25/2004

McDermott Will & Emery
600 13th Street NW
Washington, DC 20005-3096

EXAMINER	
KAO, CHIH CHENG G	
ART UNIT	PAPER NUMBER
2882	

DATE MAILED: 03/25/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/704,539	KITAMURA ET AL.	
	Examiner	Art Unit	
	Chih-Cheng Glen Kao	2882	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *20 January 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *4-23,25,26 and 28-38* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *5,17,18 and 23* is/are allowed.

6)☒ Claim(s) *4,8-16,19-22,28 and 31-34* is/are rejected.

7)☒ Claim(s) *6,7,25,26,29,30 and 35-38* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Drawings

1. The corrected replacement drawings were received on 12/19/03. These drawings are acceptable.

Claim Objections

2. Claims 4, 6-11, 13-16, 19-22, 25, 26, and 28-38 are objected to because of the following informalities, which appear to be minor draft errors creating lack of antecedent basis problems and grammatical errors.

In the following format (location of objection; suggestion for correction), the following suggestions may obviate the objections: (claim 4, lines 4-5, "excitation and function"; inserting - -the- - before "function"), (claim 4, line 7, "the p-type"; deleting "the"), (claim 4, lines 9-10, "the n-type"; deleting "the"), (claim 4, line 15, "thereof, and"; deleting the comma), (claim 6, lines 4-5, "excitation and function"; inserting - -the- - before "function"), (claim 6, line 7, "the p-type"; deleting "the"), (claim 6, lines 9-10, "the n-type"; deleting "the"), (claim 7, lines 4-5, "excitation and function"; inserting - -the- - before "function"), (claim 7, line 7, "the p-type"; deleting "the"), (claim 7, lines 9-10, "the n-type"; deleting "the"), (claim 7, line 17, "electron flowing"; replacing "electron" with - -electrons- -), (claim 7, line 18, "thereof, and"; deleting the comma), (claim 8, line 2, "said layer structure"; replacing "layer" with - -layered- -), (claim 9, line 2, "said layer structure"; replacing "layer" with - -layered- -), (claim 10, line 2, "said layer structure"; replacing "layer" with - -layered- -), (claim 11, line 2, "said layer structure"; replacing "layer"

with - -layered- -), (claim 13, lines 4-5, "excitation and function"; inserting - -the- - before "function"), (claim 13, line 7, "the p-type"; deleting "the"), (claim 13, lines 9-10, "the n-type"; deleting "the"), (claim 13, line 14, "said layer structure"; replacing "layer" with - -layered- -), (claim 14, lines 4-5, "excitation and function"; inserting - -the- - before "function"), (claim 14, line 7, "the p-type"; deleting "the"), (claim 14, lines 9-10, "the n-type"; deleting "the"), (claim 14, line 14, "said layer structure"; replacing "layer" with - -layered- -), (claim 15, line 2, "said layer structure"; replacing "layer" with - -layered- -), (claim 16, line 9, "the p-type"; deleting "the"), (claim 16, line 12, "the n-type"; deleting "the"), (claim 19, line 2, "of which"; replacing "of which" with - -photoelectric conversion unit- -), (claim 19, line 5, "excitation and function"; inserting - -the- - before "function"), (claim 19, line 8, "the p-type"; deleting "the"), (claim 19, line 11, "the n-type"; deleting "the"), (claim 20, line 1, "image sensing as"; inserting - -device- - after "sensing"), (claim 20, line 2, "said layer structure"; replacing "layer" with - -layered- -), (claim 21, line 3, "an substrate layer"; replacing "an" with - -a- -), (claim 21, line 13, "the n-type"; deleting "the"), (claim 21, line 16, "the p-type"; deleting "the"), (claim 22, line 14, "the n-type"; deleting "the"), (claim 22, line 17, "the p-type"; deleting "the"), (claim 25, line 9, "the p-type"; deleting "the"), (claim 25, line 12, "the n-type"; deleting "the"), (claim 25, line 22, "thereof, and"; deleting the comma), (claim 26, line 9, "the p-type"; deleting "the"), (claim 26, line 12, "the n-type"; deleting "the"), (claim 26, line 21, "electron flowing"; replacing "electron" with - -electrons- -), (claim 26, line 22, "thereof, and"; deleting the comma), (claim 28, line 2, "the n-type"; deleting "the"), (claim 28, line 3, "the n-type" ; deleting "the"), (claim 29, line 2, "the n-type"; deleting "the"), (claim 29, line 3, "the n-type"; deleting "the"), (claim 30, line 2, "the n-type"; deleting "the"), (claim 30, line 3, "the n-type"; deleting "the"), (claim 31, line 2,

"the n-type"; deleting "the"), (claim 31, line 3, "the n-type"; deleting "the"), (claim 32, line 2, "the n-type"; deleting "the"), (claim 32, line 3, "the n-type"; deleting "the"), (claim 33, line 2, "the n-type"; deleting "the"), (claim 33, line 3, "the n-type"; deleting "the"), (claim 34, line 2, "the n-type"; deleting "the"), (claim 34, line 3, "the n-type"; deleting "the"), (claim 35, line 2, "the n-type"; deleting "the"), (claim 35, line 3, "the n-type"; deleting "the"), (claim 36, line 2, "the n-type"; deleting "the"), (claim 36, line 3, "the n-type"; deleting "the"), (claim 37, line 2, "the n-type"; deleting "the"), (claim 37, line 3, "the n-type"; deleting "the"), (claim 38, line 2, "the n-type"; deleting "the"), and (claim 38, line 3, "the n-type"; deleting "the").

For purposes of examination, the claims have been treated as such. Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims 21 and 22 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for a carrier generation/multiplication layer composed of amorphous silicon to have both the function of absorbing light and generating carriers through optical excitation and the function of multiplying the generated carriers, does not reasonably provide enablement for a carrier generation/multiplication layer composed of amorphous silicon carbide of p-type conductivity to inhibit injection of electrons into the carrier generation/multiplication layer. The specification does not enable any person skilled in the art to

which it pertains, or with which it is most nearly connected, to make the invention commensurate in scope with these claims.

It is uncertain as to how a layer of p-type conductivity can inhibit electrons from injecting into itself. P-type material attracts electrons. It does not repel.

For purposes of examination, the claims will be interpreted as having a carrier generation/multiplication layer composed of amorphous silicon to have both the function of absorbing light and generating carriers through optical excitation and the function of multiplying the generated carriers, not a carrier generation/multiplication layer composed of amorphous silicon carbide of p-type conductivity to inhibit injection of electrons into the carrier generation/multiplication layer.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 4, 10, 15, and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takasaki et al. (US Patent 4980736) in view of Kozuka et al. (Translation of JP 09-102627) and Deane et al. (US Patent 6064091).

5. Regarding claims 4 and 15, Takasaki et al. discloses a photoelectric conversion device (Figs. 1A) comprising or consisting of a carrier generation/multiplication layer (Fig. 1B, #114) composed of amorphous silicon (col. 5, lines 44-56), an electron injection inhibiting layer composed amorphous silicon carbide of p-type conductivity (Fig. 1B, #115, and col. 6, lines 56-60), a hole injection inhibiting layer composed of amorphous silicon nitride of n-type conductivity (Fig. 1B, #113, and col. 6, lines 47-51), wherein the carrier generation and multiplication layer is between the electron and hole injection inhibiting layers.

However, Takasaki et al. does not specifically disclose the combination of silicon nitride and silicon carbide and a ratio C/Si of 1.5 or lower.

Kozuka et al. teaches the combination of silicon nitride and silicon carbide (Drawing 5, #302 and 307). Deane et al. teaches a ratio C/Si of 1.5 or lower (col. 5, lines 23-28).

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to modify the device of Takasaki et al. with the combination of silicon carbide and silicon nitride of Kozuka et al., since one would be motivated to incorporate this to create a larger multiplication factor of the signal (Paragraph 0050) of shown by Kozuka et al.

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to modify the device of Takasaki et al. with the C/Si ratio of Deane et al., since one would be motivated to have these ratios for the band gap to allow excess carriers to move more easily as shown by Deane et al. (col. 2, lines 35-41).

6. Regarding claims 10, Takasaki et al. in view of Kozuka et al. and Deane et al. suggests a device as recited above.

However, Takasaki et al. does not disclose a monocrystalline silicon substrate.

Kozuka et al. further teaches a monocrystalline silicon substrate (Paragraph 0063).

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to further modify the device of Takasaki et al. with a monocrystalline silicon substrate of Kozuka et al., since one would be motivated to incorporate this as means for storing and further processing the image signal (Paragraph 0063) as shown by Kozuka et al.

7. Regarding claim 28, Takasaki et al. further discloses the amorphous silicon nitride of n-type conductivity as hydrogenated (col. 6, lines 47-51).

8. Claims 8 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takasaki et al. in view of Kozuka et al. and Deane et al. as applied to claim 4 above, and further in view of Norström (US Patent 6077752).

For purposes of being concise, Takasaki et al. in view of Kozuka et al. and Deane et al. suggests a device as recited above.

However, Takasaki et al. does not disclose a polycrystalline or microcrystalline silicon substrate.

Norström teaches the equivalency of a polycrystalline, microcrystalline, and monocrystalline silicon substrate (col. 3, lines 10-12).

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to modify the suggested device of Takasaki et al. in view of Kozuka et al. and Deane et al. with the polycrystalline, microcrystalline, or monocrystalline silicon substrates

of Norström, since these silicon substrates were art-recognized equivalents at the time the invention was made. Thus, one of ordinary skill in the art would have found it obvious to substitute one type of silicon substrate for another.

9. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Takasaki et al. in view of Kozuka et al. and Deane et al. as applied to claim 4 above, and further in view of Nakayama et al. (US Patent 6,157,072).

Takasaki et al. in view of Kozuka et al. and Deane et al. suggests a device as recited above.

However, Takasaki et al. does not disclose a metal substrate.

Nakayama et al. teaches a metal substrate (col. 20, lines 48-55).

It would have been obvious to one having ordinary skill in the at the time the invention was made, to modify the suggested device of Takasaki et al. in view of Kozuka et al. and Deane et al. with the metal substrate of Nakayama et al. since one would be motivated to incorporate it for providing a convenient board to place the photoelectric conversion devices on (col. 20, lines 48-55) as implied from Nakayama et al.

10. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Takasaki et al. in view of Kozuka et al. and Deane et al. as applied to claim 4, and further in view of Fukuda et al. (US Patent 5635327).

Takasaki et al. in view of Kozuka et al. and Deane et al. suggests a device as recited above.

However, Takasaki et al. does not disclose boron in the carrier generation layer.

Fukuda et al. teaches boron in the carrier generation layer (col. 4, lines 48-57).

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to modify the suggested device of Takasaki et al. in view of Kozuka et al. and Deane et al. with the boron of Fukuda et al., since one would be motivated to better control dark resistance as shown by Fukuda et al. (col. 4, lines 48-57), which is related to the dark current.

11. Claims 13, 14, 16, 19, 20, and 31-34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takasaki et al. (US patent 4980736) and Kozuka et al. (Translation of JP 09-102627).

12. Regarding claims 13, 14, and 19 and for purposes of being concise, Takasaki et al. et al. in view of Kozuka et al. suggests a device as recited above.

However, Takasaki et al. does not specifically disclose a plurality of photoelectric conversion units (Drawing 14, #742), an electric field reducing layer between the multiplication layer and the carrier injection inhibiting layer, a plurality of accumulation units, and an output unit.

Kozuka et al. teaches a plurality of photoelectric conversion units (Drawing 14, #742), an electric field reducing layer between the multiplication layer and the carrier injection inhibiting layer (Abstract, problem to be solved), a plurality of accumulation units (Drawing 14, #741), and an output unit (Drawing 14, #750).

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to further modify the device of Takasaki et al. with the photoelectric conversion, accumulation, and output units of Kozuka et al., since one would be motivated to incorporate this to convert a larger image with more pixels (Drawing 14) as implied from Kozuka et al.

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to further modify the device of Takasaki et al. with the electric field reducing layer of Kozuka et al., since one would be motivated to incorporate this to further reduce dark current caused by interfacial defects (Abstract, problem to be solved) as shown by Kozuka et al.

13. Regarding claim 16 and for purposes of being concise, Takasaki et al. et al. in view of Kozuka et al. suggests a device as recited above.

However, Takasaki et al. does not disclose an energy level at an interface between the amorphous silicon carbide layer and the amorphous silicon layer discontinued on a conduction band side and equal on a valence band side.

Kozuka et al. teaches an energy level at an interface between the amorphous silicon carbide layer and the amorphous silicon layer discontinued on a conduction band side and equal on a valence band side (Drawing 8, interface between #402 and 203).

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to further modify the device of Takasaki et al. with energy level interface of

Kozuka et al., since one would be motivated to incorporate this to more easily flow carriers (Drawing 8) as implied from Kozuka et al.

14. Regarding claim 20, Takasaki et al. further discloses the layered structure consisting of the carrier generation/multiplication layer, the electron injection inhibiting layer, and the hole injection inhibiting layer (Fig. 1A).

15. Regarding claims 31-34, Takasaki et al. further discloses the amorphous silicon nitride of n-type conductivity as hydrogenated (col. 6, lines 47-51).

Allowable Subject Matter

16. Claims 5-7, 17, 18, 23, 25, 26, 29, 30, and 36-38 contain allowable subject matter.

17. Claims 21 and 22 would contain allowable subject matter if rewritten or amended to overcome the rejection(s) under 35 U.S.C. 112, second paragraph, set forth in this Office action.

18. The following is a statement of reasons for the indication of allowable subject matter.

Regarding claims 6, 7, and 21, prior art does not disclose or fairly suggest a photoelectric conversion device including an energy level interface between an amorphous silicon nitride layer and an amorphous silicon layer discontinued on a valence band side and equal on a conduction band side, in combination with all the limitations in the claim. Claims 5, 23, 29, 30, and 35 contain allowable subject matter by virtue of their dependency.

Regarding claims 22, 25, and 26, prior art does not disclose or fairly suggest a solid-state imaging device including an energy level interface between an amorphous silicon nitride layer and an amorphous silicon layer discontinued on a valence band side and equal on a conduction band side, in combination with all the limitations in the claim. Claims 17, 18, and 36-38 contain allowable subject matter by virtue of their dependency.

Response to Arguments

19. Applicant's arguments with respect to claims 4, 8-16, 18, 19, 28, and 31-34 have been considered but are moot in view of the new ground(s) of rejection.

20. Applicant's arguments filed 1/20/04 have been fully considered but they are not persuasive.

Regarding Takasaki, et al., the reference is still relied upon with its disclosure of the general device as recited above.

Regarding Kozuka et al., the reference is still relied upon with its teaching of the electric field reducing layer, the plurality of units, the combination of silicon nitride and silicon carbide in the same device, and the energy levels as recited above.

Regarding Nakayama et al., the reference is still relied upon with its teaching of a metal substrate as recited above.

Regarding Fukuda et al., the reference is still relied upon with its teaching of boron as recited above.

Regarding to Deane et al., the term "image sensor" (col. 1, lines 15-20) in combination with the disclosure of the semiconductor layer as "photoconductive" and causing "photocurrents due to light absorption" (col. 1, lines 40 and 42-44) is enough evidence, with certainty to someone with ordinary skill in the art, that such a sensor is a photoelectric conversion device. Furthermore, one of ordinary skill in the art, in viewing with the additional references of prior art (i.e. Takasaki et al. and Kozuka et al.), would have also found it obvious that the "image sensor" of Deane et al. is a photoelectric conversion device, since all the devices in these references use semiconductor layers to convert light to a current. Deane et al. also discloses a sandwich structure (Fig. 1).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Chih-Cheng Glen Kao whose telephone number is (571) 272-2492. The examiner can normally be reached on M - F (9 am to 5 pm).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ed Glick can be reached on (571) 272-2490. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

DAVID V. BRUCE
PRIMARY EXAMINER

gk